United States Department of Agriculture | Forest Service | Northeastern Area State & Private Forestry | 180 Canfield Street Morgantown, WV 26505

Reply To: 3460/3410

Date: January 26, 1994

Mr. Allen Carter
Regional Forester, R-5
USDI Fish and Wildlife Service
P.O. Box 349
Sufolk, VA 23434

Dear Mr. Carter:

Enclosed for your information is the gypsy moth biological evaluation for Blackwater National Wildlife Refuge. Site-wide egg mass densities ranged from 40-27,600 and averaged 5711 egg masses per acre. We anticipate widespread moderate and heavy defoliation to occur on approximately 1700 acres if left untreated. Our recommendation is to aerially treat these 1700 acres using B.t. applied in one application at the rate of 36 BIUs per acre.

I hope this information will prove useful to you. If you have any questions, call Brad Onken or myself at (304) 285-1541.

We look forward to working with you in the spring!

Sincerely,

Rodney L. Whiteman

RODNEY L. WHITEMAN
Forestry Technician
Forest Health Protection

Enclosures

cc: AO
Bill Giese
Larry Hartis
Robert Tichenor, MDA
Steve Tilley, MDA

RLW/mae

STATUS OF GYPSY MOTH POPULATIONS AT BLACKWATER NATIONAL WILDLIFE REFUGE

Prepared by

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and
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FOREST HEALTH PROTECTION
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INTRODUCTION

On October 4-6, 1993, USDA Forest Service personnel conducted a gypsy moth egg mass survey at Blackwater National Wildlife Refuge. The purposes of the survey were to evaluate the efficacy of the Gypchek treatment areas and to assess the potential for defoliation and the need for treatment elsewhere in the Refuge in 1994.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oaks and sweet gum), size of sample area, uniformity between egg mass counts, and available time. At each sample point, a 1/40th acre fixed-radius plot was established.

The fixed-radius plots (radius 18.6 feet) consisted of a tally of all the new (1993) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was then multiplied by 40 to determine egg masses per acre using the following equation:

$$Y = 40X$$

where,

Y = egg masses per acre

X = number of egg masses observed in the plot

RESULTS

The results of the survey are presented in Table 1. The survey plot locations are shown in Figures 1 and 2. Egg mass densities ranged from 40-27,600 and averaged 5711 egg masses per acre throughout the Refuge. Only four of the twenty stands surveyed had egg mass densities that averaged less than 1000 egg masses per acre and three of the stands had egg mass densities that averaged over 10,000 egg masses per acre. Overall, egg masses were large (quarter size and larger) and appeared healthy. Oaks and sweet gum, preferred foods of the gypsy moth, comprise at least 21 percent of the basal area in each stand surveyed except for Stand 9. In this stand, oaks and sweet gum comprised 10-20 percent of the basal area.

The 1993 Gypchek treatment areas encompassed Stand 10, the western portion of Stand 11 and the northern portion of Stand 12 (Figure 2). Egg mass densities in Stand 10 decreased by 85 percent from the pre-treatment level of 6760 to the current level of 1040 egg masses per acre. Egg mass densities in Stand 11 decreased by about 40 percent from the pre-treatment level of 5420 to 3200 egg masses per acre while egg mass densities in the treatment area in Stand 12 increased slightly from an average of 4548 to the current level of 4576 egg masses per acre.

DISCUSSION

The basic guidelines used to predict the degree of defoliation include evaluation of the past defoliation history of the area in question, number of egg masses/acre, size and condition of the egg masses, available preferred food, terrain and risk of larval blow-in following egg hatch. Potential defoliation is categorized as follows: light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

Gypsy moth populations are sufficient to cause heavy defoliation throughout much of Stands 3,4,6,7,10,11,12,13,56,57,60,61,62,63,64 and 65, while moderate defoliation is likely to occur in Stand 58

(Figures 3 and 4). These stands cover approximately 1700 acres. Small scattered areas of light to moderate defoliation may occur in Stands 1,5 and 9, however it is not expected to be widespread. No noticeable defoliation is likely to occur elsewhere at Blackwater National Wildlife Refuge in 1994.

Egg mass densities in 16 stands at Blackwater National Wildlife Refuge exceed the treatment threshold of 1000 egg masses per acre commonly used by timber managers to prevent tree mortality (Table 2). In Stands 1,5,9 and 58, defoliation may occur, but it will be more severe and widespread in Stand 58 because it has a higher gypsy moth hazard rating than the other three stands based on the stand's basal area in preferred hosts of the gypsy moth (i.e. oaks and sweetgum).

The results of this survey should be used in conjunction with resource management objectives to assess the potential impact that both heavy defoliation and possible tree mortality would have in meeting your management goals. Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality.

In general, trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (<60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth and minor branch dieback.

Trees at greater risk for branch dieback or mortality are those that are presently stressed from other factors, such as: 1) soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; 2) over maturity; 3) drought; 4) shock due to recent timber cutting activities; 5) previous year(s) defoliation; and 6) other insect and disease related problems. In 1993, heavy defoliation occurred in Stands 12 and 61 while moderate defoliation occurred in Stands 4,6,60,61,62,64 and 65 (Figures 3 and 4).

An example of the potential impact is provided by the Allegheny National Forest. In untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In this case, droughty conditions likely contributed to the level of mortality.

The results of the 1993 Gypchek treatment are somewhat disappointing. Although foliage protection was achieved throughout much of the treatment area, significant population reductions did not occur. All three treatment blocks have residual gypsy moth populations that are sufficient to cause heavy defoliation in 1994. Gypchek has the potential to be efficacious in reducing gypsy moth populations but with any biological insecticide, the results can be quite variable.

For 1994, three management options have been evaluated for managing gypsy moth populations at Blackwater National Wildlife Refuge. The intervention options are offered based upon the following treatment objectives: 1) protecting host tree foliage; 2) preventing tree mortality; and 3) reducing gypsy moth populations below treatment thresholds. Each is discussed below and consider the primary resource management objective of protecting Delmarva fox squirrel habitat.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of NPV (nucleopolyhedrosis virus) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating level gypsy moth populations (greater than 250 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will

usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with the information at hand, the large egg mass size and the recent population build-up at Blackwater National Wildlife Refuge suggest that this population as a whole is still building and a collapse is not likely to occur in 1994.

Should this option be selected, it is likely that population densities will increase and possibly expand to currently uninfested areas at this facility.

Chemical Insecticide Option

The second option is to use a chemical insecticide to control gypsy moth populations. Dimilin® (diflubenzuron) is the most widely used chemical insecticide in gypsy moth suppression projects in the northeast. Diflubenzuron (DFB) is an insect growth regulator that disrupts the normal molting processes of the larvae. The mode of action is to inhibit the formation of chitin, a necessary component of the outer cuticle which causes the affected larvae to die during the molt following treatment. The method of uptake is primarily by ingestion, however, some research has indicated the possibility of absorption through the cuticle as well. DFB is relatively persistant on foliage (24 days) which increases the efficacy on gypsy moth populations but also unfortunately exposes non-target caterpillars for a greater period of time.

Dimilin is registered by EPA for use in residential areas. It is, however, extremely toxic to some aquatic invertebrates including crab and shrimp, and the label prohibits the application over open water or wetlands. The Maryland Department of Agriculture's current policy on the use of DFB is to provide a minimum of a 100-foot no-spray buffer around open waterways and wetland areas. DFB is available as a 25 percent wettable powder (Dimilin 25W), and an oil based liquid formulation (Dimilin 4L). Both formulations are normally applied in a single application and the standard rate of application is 1-2 ounces of formulated material per acre. With proper application, foliage protection and a significant population reduction can be expected with DFB. The need for treatment of residual populations the following year is normally not necessary.

Microbial Insecticide Option

The third option is to use a microbial insecticide to manage gypsy moth populations. The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringiensis* variety *kurstaki* (*B.t.*). This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *B.t.* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. Although *B.t.* is considered to be more host specific than DFB, it has been shown to impact other non-target caterpillars that are exposed to the treatment and are actively feeding. *B.t.* is persistant on foliage for about 7-10 days.

B.t. formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 20-36 billion international units (BIUs) per acre in a single application and 16-30 BIUs in double applications. *B.t.* can be applied either undiluted or mixed with water for a total volume of 1/2-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely. Because *B.t.* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, population densities, weather (rain and temperature), the feeding activity of the larvae following treatment and the actual potency of the product.

The nucleopolyhedrosis virus (NPV) product, Gypchek, is another microbial insecticide that can be used. The NPV has an extremely narrow host range and occurs naturally in gypsy moth populations. Normally, the virus

reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. Gypchek is not available commercially as of yet, but the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS) has registered and produced the product in limited quantities.

To date, the efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (5-6 days) as well as other biological factors such as feeding activity and weather conditions, it is difficult to project treatment efficacy. We do expect however, that adequate foliage protection would be achieved.

The normal application rate of Gypchek is $5x10^{11}$ polyhedral inclusion bodies (PIBs) per acre. In addition to the virus, the formulation includes lignocite (a sunscreen), field grade molasses (feeding stimulant), Bond (sticker) and unchlorinated water in a total mix of 2 gallons per acre. The treatment requires that two applications be applied three days apart.

Alternatives

With the previously described options in mind, the following five (5) alternatives are offered.

Alternative 1. -- No action.

Alternative 2. -- Single application of DFB.

Alternative 3. -- A single application of *B.t.* applied at the rate of 36 BIUs in a total mix of 1/2-1 gallon per acre.

Alternative 4. -- Two aerial applications of *B.t.* at the rate of 16-30 BIUs in a total mix of 1/2-1 gallon per acre. The second application should be applied 5-7 days following the first.

Alternative 5. -- Two aerial applications of Gypchek applied at the rate of $5x10^{11}$ PIBs in a total mix of 2 gallons per acre. The second application should be applied 3 days after the first.

RECOMMENDATIONS

As previously stated, gypsy moth populations are sufficient to cause moderate to heavy defoliation in 17 stands totalling approximately 1700 acres at Blackwater National Wildlife Refuge in 1994. As a result, some direct action should be taken to protect tree foliage and prevent tree mortality in order to protect the habitat of the Delmarva fox squirrel. Our recommendation is to implement Alternative 3 on these 1700 acres. Treatment elsewhere at Blackwater National Wildlife Refuge will not be necessary.

Alternative 3 was selected based on the following considerations.

1) DFB is toxic to aquatic invertebrates and many of the proposed treatment areas are near aquatic environment.

2) A single application of *B.t.* at a higher rate is more economical than two applications at a lower rate.

3) Foliage protection and an adequate population reduction below retreatment thresholds can be achieved.

4) A limited supply of Gypchek is available and the priority for its distribution is to areas containing T&E species of lepidopterans that would be impacted by other insecticide choices. This is not the case at Blackwater NWR.

5) If Gypchek was applied, retreatment would be likely in 1995.

Table 1.--Gypsy moth egg mass survey results at Blackwater National Wildlife Refuge, October 4-6, 1993.

Stand Number	Plot Number	Number EM/Acre
1 1 1 1 1 1	30 31 32 33 34 38	200 80 440 680 2,320 1,520 Range = 80-2,320 EM/Acre Average = 873 EM/Acre
3 3	35 36	3,200 9,720 Range = 3,200-9,720 EM/Acre Average = 6,460 EM/Acre
4 4 4	6 7 8	12,400 3,560 13,840 Range = 3,560-13,840 EM/Acre Average = 9,933 EM/Acre
5 5	11 39	1,000 400 Range = 400-1,000 EM/Acre Average = 700 EM/Acre
6 6 6 6 6 6	1 2 3 4 5 42	4,960 11,440 7,040 12,880 3,520 120 Range = 120-12,880 EM/Acre Average = 6,660 EM/Acre
7 7 7 7	9 10 12 37	200 840 1,720 4,440 Range = 200-4,400 EM/Acre Average = 1,800 EM/Acre
9 9	40 41	360 920 Range = 360-920 EM/Acre Average = 640 EM/Acre

Stand Number	Plot Number	Number EM/Acre
10 10	43 44	1,000 1,080 Range = 1,000-1,080 EM/Acre Average = 1,040 EM/Acre
11 11	53 59	3,200 11,760 Range = 3,200-11,760 EM/Acre Average = 7,480 EM/Acre
12 12 12 12 12 12 12 12	46 47 48 49 50 51 52 58	1,720 1,640 5,400 10,880 5,720 12,840 960 7,760 Range = 960-12,840 EM/Acre Average = 5,865 EM/Acre
13 13 13 13	54 55 56 57	1,920 1,440 5,640 1,320 Range = 1,320-5,640 EM/Acre Average = 2,580
56 56	64 65	2,560 2,480 Range = 2,480-2,560 EM/Acre Average = 2,520 EM/Acre
57	63	3,880
58 58 58	60 61 62	160 1,800 40 Range = 40-1,800 EM/Acre Average = 667 EM/Acre
60 60 60	13 14 15	11,680 9,680 23,400 Range = 9,680-23,400 EM/Acre Average = 14,920 EM/Acre

Stand Number	Plot Number	Number EM/Acre
61 61 61	18 19 45	17,120 9,760 3,320 Range = 3,320-17,120 EM/Acre Average = 10,067 EM/Acre
62 62 62	20 21 22	16,880 6,120 920 Range = 920-16,880 EM/Acre Average = 7,973 EM/Acre
63 63 63	16 17 27	10,720 4,120 13,920 Range = 4,120-13,920 EM/Acre Average = 9,587 EM/Acre
64 64 64	26 28 29	27,600 1,720 10,120 Range = 1,720-27,600 EM/Acre Average = 13,147 EM/Acre
65 65 65	23 24 25	6,680 7,200 7,240 Range = 6,680-7,240 EM/Acre Average = 7,040 EM/Acre

Table 2.--Average number of egg masses per acre and gypsy moth hazard rating at Blackwater National Wildlife Refuge, October 4-6, 1993.

Stand Number	Average Number of EM/Acre	Gypsy Moth Hazard Rating*
1	873	Moderate
3	6,460	Moderate
4	9,933	High
5	700	Moderate
6	6,660	Moderate
7	1,800	Moderate
9	640	Low
10	1,040	High
11	7,480	High
12	5,865	High
13	2,580	Moderate
56	2,520	Moderate
57	3,880	High
58	667	High
60	14,920	Moderate
61	10,067	High
62	7,973	Moderate
63	9,587	Moderate
64	13,147	Moderate
65	7,040	Moderate

*Based on stand-level susceptibility to gypsy moth defoliation as it relates to species composition (adapted from Herrick and Gansner (1986) by Gottschalk, 1993).

Figure 1. -- Gypsy moth egg mass survey plot locations at Blackwater National Wildlife Refuge, October 4,5,6, 1993.

ure 2. -- Gypsy moth egg mass survey plot locat[illegible]s and
1993 gypsy moth suppression spray blocks at
Blackwater National Wildlife Refuge, October 4,5,6, 1993.

FIGURE 3. 1993 defoliation areas and areas where defoliation is likely to occur in 1994 at Blackwater National Wildlife Refuge.

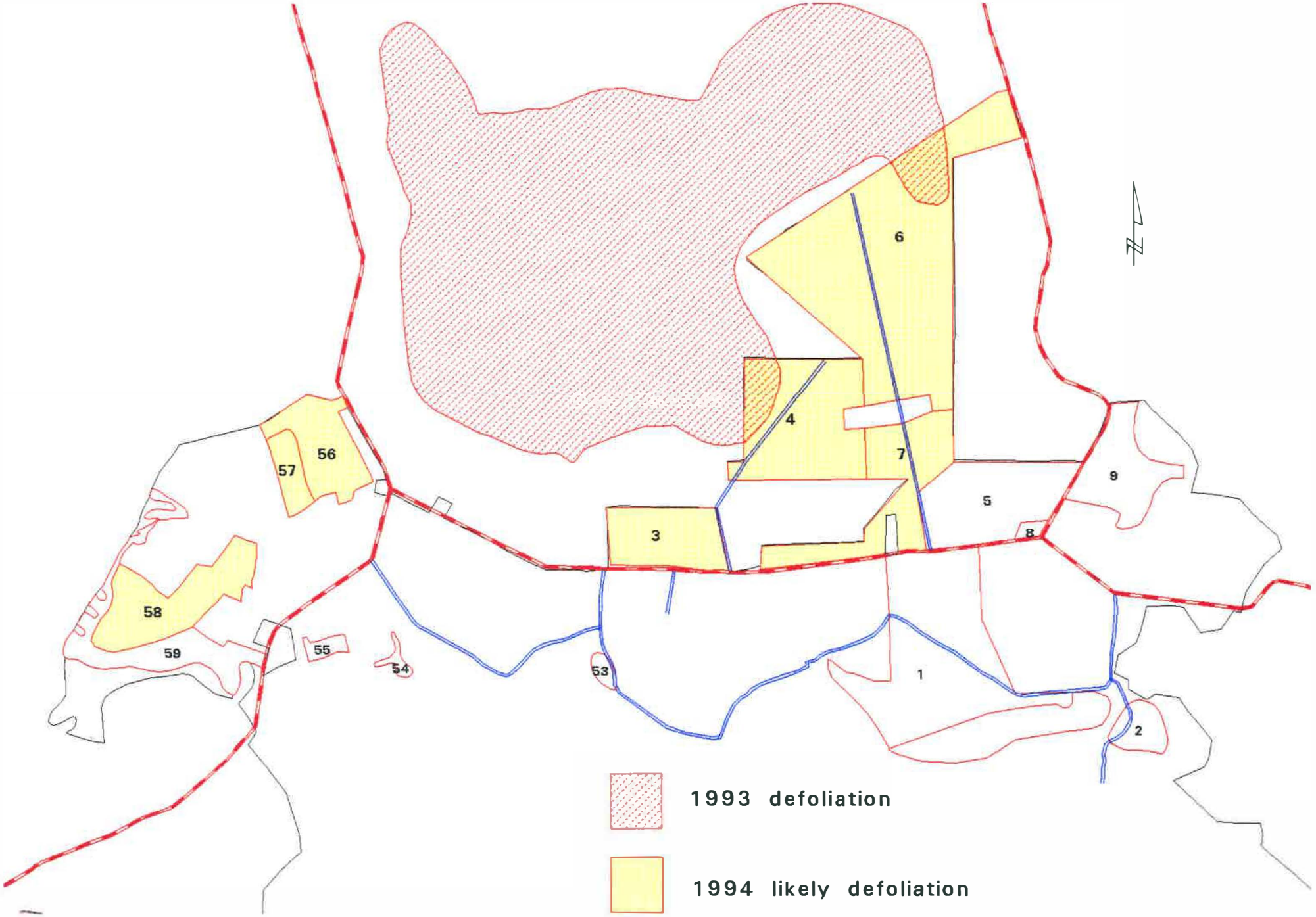

FIGURE 4. 1993 defoliation areas and areas where defoliation is likely to occur in 1994 at Blackwater National Wildlife Refuge.